



# Ø BEAT

COLO. SPRINGS,  
COLORADO

AUGUST 1983

## Take It With A Grain Of Salt . . .

**TEKNIKLE TOPIX**  
**Your SWR is 1.05 to 1?**  
**Oh, come now!!**

The above statement as to value of the standing wave ratio on an antenna is often heard over the air waves. I will make a rash rebuttal to this claim — BUNK (or something worse!) The average amateur will more than likely never have nor ever have access to test equipment than can accurately measure a standing wave ratio of 1.05 to 1. You would probably like some explanation, right?

Let's first take a look as to what SWR is in simple terms. If we have a load on the end of our transmission line that is exactly matched to the characteristic impedance of the line, all of the power in the transmission line will be absorbed by our load. I have assumed that our transmission line has no loss because this brings up another set of problems.

If the load is not equal to the characteristic impedance of the transmission line, we have what is called a mismatched condition. The power headed to the load is not totally absorbed by the load because the load now requires a different voltage/current ratio for maximum power transfer. Thus the load only absorbs part of the power reaching it (commonly called incident or forward power). What is left acts as if it is bounced off a wall and starts back down the transmission line toward the transmitter. This is commonly called reverse or reflected power. The greater the mismatch, the larger the amount of power that will be reflected. If our load is zero or infinity ohms resistive, all of the power will be reflected.

The coincidence of both forward and reflected power in our line creates what we call standing waves. Actually they are the vector sums of the voltage and current waveforms at any point on the transmission line. It is interesting to note that the vector sum of these waves one-half wavelength away from the load is exactly the

same as the vector sum at the load. This is repeated every one-half wavelength away from the load.

We can use these standing waves to give us an indication of how well our antenna is matched to our transmission line. The ratio of the maximum voltage on the line to the minimum voltage is called the Voltage Standing Wave Ratio or VSWR. Many people just shorten this to SWR. The same is also true of the currents in the line so either can be used for measurement.

VSWR bridges use different circuit arrangements for measurements but they all accomplish the same task (excluding the accuracy of course). We end up measuring the ratio of the incident and reflected voltage to give us an indication of VSWR.

Forward/Reflected power meters are, of course, calibrated in units of RF power (watts). By using some simple equations we can calculate the SWR if we know the forward and reflected powers. Published charts are also available to simplify this task.

In dealing with the accuracy of our measurements we must deal with something called directivity. Directivity gives us a measure of how well the VSWR Bridge or power meter we are using can distinguish between forward and reverse power. The venerable Bird wattmeter has a directivity of greater than 30db which is quite good. Directivity is where many diode-type VSWR bridges such as the Heath HM 2102 falls short. Remember the "SWR Null" adjustment that did not look so good? That's a big part of it. Also we can run into trouble with the power levels the diodes are subjected to because we can drive the diode monitoring the incident power out of it's square-law region and into its linear region and ruin our measurement accuracy.

Even the Bird Model 43 wattmeter has its limitations. One is that the stated accuracy of the measuring

(continued on page 6)

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The Pikes Peak Radio Amateur Association meets on the second Wednesday of every month at the Palmer House Motel, I-25 and Fillmore, at 7:30 p.m. All amateurs and interested parties are invited to attend.

Editor: Don Lohse KBØKQ, 1410 E. LaSalle, Colorado Springs, CO 80907 635-7469

### MEETING MINUTES

The July meeting of the PPRAA was called to order by Vice President Charlie Biggs at 7:34 p.m. Introductions were made and the Treasurer's report given.

A well deserved round of thanks was voted for all who gave of their time and effort for the Sports Festival. Special thanks to Bob KØDJ and Steve NØST. Ken WØTGL handed out medallions to those that missed the dinner, and then read an estimate of the value of the time and equipment given during this event of \$100,000. Some problems during the Festival were discussed. A letter to Bob Mathias asking for the use of Bldg. 69 at OTC was read.

Bob KØDJ gave a report on the Commemorative station and the 1010 contacts made. Bob gave special thanks to Joe NØEMN for sleeping in the building to guard the equipment. Kudos also to Frank and Al for all their assistance.

The cost of the meeting place was discussed, and a motion passed to meet there one more month.

KØDJ announced that the club license will expire in the near future, and a new trustee is needed. Help us keep WAØVTU!

Dick Kohlhaas W5UDM of Channel Communications spoke to the members concerning a source for equipment in town with the closing of AES.

Special thanks was voted for all the non-ham people who helped out at Sports Festival. Zero Beat will acknowledge them all in a future issue. A thank you letter to Miley's was also voted.

Bob, Charlie and Mark will be the hiders at the Club picnic, with the hunt starting at 2:00 p.m.

The meeting was adjourned at 10:00.

Respectfully submitted  
Charlie KCØTI for Mark  
NØEPF

### MEETING NOTICE

The August meeting of the Pikes Peak Radio Amateur Association will be held on August 10 at 7:30 p.m. at the **Palmer House Motel on N. Chestnut Street (just north of I-25 and Fillmore.)** The program is scheduled to cover the expanding field of amateur television and introduce the members to the equipment, procedures and results of this form of communication.

All members and other interested persons are encouraged to attend.

**Due to space restrictions, the diagrams accompanying the Meteor Burst article were not printed in this issue, but will be in the next. Our apologies for any inconvenience.**

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# METEOR-BURST COMMUNICATIONS BOUNCE SIGNALS BETWEEN REMOTE SITES

By Willis E. Day, Scientific Radio Systems,  
Rochester, N. Y.

## Part Two OPERATIONAL EXPERIENCE

Two existing Government meteor-burst systems have provided valuable operating data. For example, total throughput is influenced by the data transmission rate and by the equipment's operating mode: broadcast, half-duplex, or full-duplex.

Snetel (Snowpack Telemetry System) experience shows that it takes less than 2 minutes to transmit a short message between a full-duplex master station and a half-duplex remote data terminal. If full-duplex master stations are used on both ends of a link, the data rate can exceed 100 words per minute in each direction. Where half-duplex transmission is used at a master station the data rate would be about 70% that obtained with a full-duplex master station in point-to-point service.

Broadcast mode is very inefficient by comparison, but for short messages it can be a useful means of communications to a station or a group of stations. Snetel has also shown that 60 sites can be contacted in less than 5 minutes using short group addresses.

Full-duplex operation of the master station, although about 20% more expensive, provides the higher through-put rates required in telecommunications applications. Remote stations usually operate in the half-duplex mode, allowing the use of simpler equipment,

they may be full-duplex mode, allowing the use of simpler equipment, but they may be full-duplex for higher through-put in these applications. The transmit duty cycle of the remote station is kept low compared to the master station by transmitting only after the master

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Dick Kohlhaas, W5UOM

station finds a meteor trail that will link the two. This minimizes remote-station power and heat-sinking requirements.

Because it usually takes several meteor trail channels to complete a message, the message protocol of the transmitted meteor-routed signal is important. The complete protocol comprises three message format: The master-to-remote, the remote-to-master, and the master-acknowledge-remote, (See Fig. 2).

## UNIQUE PROTOCOL

The master-to-remote signal establishes the meteor channel and defines the type of information to be communicated. A typical format has four fields. Field 1 is a 9-bit group used to set phase-locked-loop synchronization at the receiver. Field 2 is an 8-bit group made of 6 bits to set block synchronization and 2 bits as a probe command to request data or listen. Field 3 is a 10 bit station address. Field 4 is a variable-length field, which is 15 bits long for commands and up to 24 six-bit characters. The first bit of field 4 is the data/command bit used by the remote station to determine if the following bits are a command or a message.

The master-to-remote signal can be sent in three ways: as a universal probe to all system remote stations, as a specific-station probe, and as a command or message. The universal probe is simply the first two fields of the format and is used to establish a channel with any answering station. The specific-station probe adds the field 3 address to the universal probe.

The remote-to-master signal is also composed of four fields. However, field 1 is 40 bits long to ensure phase synchronization of the low-index PSK receiver. Field 2 is now only 6 bits because the probe command is deleted. Field 3 is the station address for use in multiple remote systems. Field 4 is made of up to 256 bits of data and a 9-bit cyclic-redundancy-checking code.

The master-acknowledge-remote signal is a special three-field format used to acknowledge receipt of a message from a remote station. It allows for the message piecing mode of communication, a remote unit will continue to send until it receives the acknowledgment.

In a message-piecing mode, if the message is not completed or the path is lost, the master station transmits a probe signal with a command in search of



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### Meteors (cont.)

another meteor channel. This command directs the remote terminal to start from the point where communications was interrupted and to continue from there until the message is completed. In a single block-transfer mode, if the entire block was not received, there will be no acknowledge signal and the block will automatically be retransmitted until acknowledged.

### MASTER CONTROL

The three basic types of terminals (fig. 3) used in current meteor-burst communications systems are the SRM-510 and SRM-520 master stations, the SRM-550 remote data terminal, and the SRM-540 remote communications terminal. Each is under computer control: a minicomputer at the master station and microprocessors at the remote units. Therefore each can

specialized system functions.

The master station controls both the communications protocol and the dissemination of the received information. The received data may be automatically routed to a teletypewriter or CRT display, into a computer memory for data logging, or into a modem for transmission over telephone lines.

The master station equipment usually consists of 500 or 1000 watt transmitter, a receiver, an antenna with duplexer, and a minicomputer system. The equipment is usually rack mounted but can be set up for portable operation.

The master station transmitter consists of a crystal-controlled oscillator-modulator, and rf amplifier, a transmitter interface, and a power supply. The oscillator drives a phase-shift-keyed modulator, followed by a low-level buffer amplifier. The rf signal is amplified by Class C solid-state amplifier before application to the input of the power amplifier. The transmitter interface circuit provides buffering and signal conditioning between the exciter, preamplifier, computer, and the status-and-control system.

The master station receiver consists of three circuit cards: an rf-if-mixer, demodulator, and a self-testing

(continued on page 5)

### BOARD MEETING

The Board meeting of the Pikes Peak Radio Amateur Association was called to order at 7:45 p.m., July 18, at the home of Bud. Present were Dave, NØDV; Bud, NØDDF; Les, KCØNC; Mark, NØEPF; Karl, K4DQ; Charlie, KCØTI; and Tom, ADØO.

Meetings at the Palmer House were the first item on the agenda. The Palmer House seems to be preferred. The price, however, appears high. The feeling was that \$15.00 to \$20.00 a month would be acceptable. Tom indicated \$20.00 would probably be the minimum cost. Discussions will continue.

Mark gave notice that he was resigning the chairmanship of the Public Relations Committee. He indicated he would be glad to assist the new chairman when chosen.

Les reported the treasury had a balance on July 18 of \$2965.80.

Mark presented the new ARRL proposal of affiliated clubs becoming Special Service Clubs. The PPRAA already meets all the criteria for an SSC. The benefits in adopting an SSC status are numerous and interesting. Mark moved, Bud seconded that the Special Service Club proposal be presented to the membership for adoption at the next meeting. Motion passed unanimously. Upcoming programs are planned as; August—ATV; September—speaker to be decided; October—elections.

Nominees are needed for the October elections. Persons will be contacted by the board. Others who are interested in serving should contact a board member. The board terms of Mark, Karl, Bud and Tom will be completed this year.

Les will try to reserve the Polka Club for Sunday April 15, 1984 for the PPRAA Swapfest.

July 23rd the Colorado Council of Amateur Radio Clubs will have a large meeting in Glenwood Springs. Oak was designated as the official club delegate.

A mall demo is possible at Chapel Hills Mall around Thanksgiving. A coordinator is needed to head a technical committee for the project. This will be brought up at the next club meeting.

There being no further business before the board, the meeting was adjourned at 9:45 p.m. Next board meeting will be at Tom's home, August 15.

Respectfully Submitted  
Mark NØEPF

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## Meteors (cont.)

module that drives a status panel. On this panel are a receiver noise-level meter and test points for monitoring internal control functions.

The 1-MHz output of the crystal-controlled rf-if-mixer card is applied to a PLL low-index linear PSK demodulator to provide carrier synchronization and bit detection. The data output of the demodulator is routed to the computer over the control-logic interface.

The self-testing module continually monitors the operation of the master station so that the operator can determine if a fault exists. A self-testing data pattern is modulated on a test transmitter and sent into the main receiver. The data output of the main receiver is fed to the computer for comparison with the original test pattern, thus providing a test of the master station receiver and computer.

The communications processor of the SRM-510/520 master stations consists of a Nova 4/C minicomputer, a general-purpose interface card, and an operator terminal. However, custom systems using any 16-bit general purpose computer configured with 64-K bytes of memory, a real-time clock, automatic restart for power-failures, and battery back-up are possible. Eight inch floppy disk storage is also typically used.

## REMOTE CONTROL

The remote terminals of the SRM-500 series consist of a 300 watt solid-state transmitter, the associated receiver, and an Intersil 6100 12-bit microprocessor for data acquisition and processing, message-protocol formatting, and transceiver control. The data terminal contains its own switch-selectable address code to allow interchangeability of units in the field for maintenance.

In a communications application, the operator terminal is connected to the transceiver through a 300 baud RS-232-C interface.

In typical half-duplex operation, the remote station's transmitter is off until an interrogating signal with the correct address is received. The transmitter then responds with a message or data block. Communications will continue under command of the master station until all data has been sent or the meteor trail is lost.

Remote stations are usually powered by batteries with recharging from primary ac power or solar panels. In data-acquisition applications, provision is made to interface with standard sensors for data accumulation and transmission. Each remote station has a capability for 16 input sensors, with 12 data bits available for each sensor.

The remote unit can also be configured as a communications terminal using its RS-232-C interface port for message insertion from an alphanumeric keyboard or a host system. The same interface port is used for system setup and equipment checkouts employing a companion test set. The same interface port is used for system setup and equipment checkouts employing a companion test set. The remote unit's microprocessor buffers data and controls message-transmission protocol. The master station can acknowledge receipt of a complete message or message blocks using the acknowledge signal.

Thanks to QSP, March 1983  
(From ELECTRONICS, December 19, 1982, pp. 71-79)

## SWR (cont.)

elements is  $\pm 5\%$ . This is very good but it does not set limitations for use in measuring power.

Lets look at an example. If we let

$$\begin{aligned} O &= \frac{\text{Reverse Power}}{\text{Forward Power}} && \text{then} \\ \text{VSWR} &= \frac{1 + O}{1 - O} \end{aligned}$$

Assuming we have 10 watts forward power and 1 watt reflected (10% reflected), we can calculate a VSWR of 1.92 to 1. If we have 4% reflected power our VSWR is 1.5 to 1.

Now here is the kicker. To be able to measure a VSWR of 1.05 to 1, we must be able to accurately measure 0.06% of our forward power. For 10 watts forward power we must be able to measure 6 milliwatts of reflected power!

Bird Electronics tells the user of its Model 43 instrument that one can only measure VSWR accurately down to about 1.5 to 1 if the user uses a single measuring element. If the element measuring the reverse power is one-tenth the rating of the forward element (100 watt

and 10 watt elements for example), Bird states that one can accurately measure VSWR down to about 1.16 to 1. Detection of VSWR can be lower but its accuracy is questionable.

So we can see that a big part of our measurement of VSWR deals with the accuracy of our instruments. I did some experimentation along this line using a Bird Model 43, Heath HM2102, some calibrated mismatches, isolation attenuators, and a 10 watt transmitter and was amazed with the results. The Bird 43 was always within its stated accuracy even at different power levels. The HM2102 showed errors as much as 15% and the amount of error varied with power level. I am not picking at Heath about the accuracy of their instrument. For the money it is a fine addition to the hamshack but its performance is typical of many VSWR bridges. These units can be readily used to adjust matching for a minimum, VSWR but do not be surprised if the actual VSWR is not what the meter tells you. So, before you make any wild claims be sure of the accuracy of your test equipment.

Watson Gabriel WB4EXW

May 79 Carolina-Virginia Rptr. Assn. Journal



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